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jc490 U.S. PTO

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Wikstedt et al.

Serial No. TO BE ASSIGNED

Corresponding to PCT/FI99/00566, filed 24 June 1999

Filed: November 1, 2000 Docket No.: 796.375USW1

Title: HANDOVER-METHOD IN A CELLULAR RADIO SYSTEM

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09/704208  
11/01/00

CERTIFICATE UNDER 37 C.F.R. 1.10:

'Express Mail' mailing number: EL605624741US

Date of Deposit: November 1, 2000

The undersigned hereby certifies that this Transmittal Letter and the paper or fee, as described herein, are being deposited with the United States Postal Service 'Express Mail Post Office To Addressee' service under 37 CFR 1.10 and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231

By:

Lauren Tran

Box Patent Application  
Assistant Commissioner for Patents  
Washington, D.C. 20231

**REQUEST FOR CONTINUATION OF AN INTERNATIONAL APPLICATION**  
**UNDER 37 C.F.R. §1.53(b)**

This is a request for filing a continuation application under 37 C.F.R. §1.53(b) of prior pending international application number PCT/FI99/00566 filed on 24 June 1999 entitled HANDOVER-METHOD IN A CELLULAR RADIO SYSTEM, which designated the United States.

1. ☒ Enclosed is a patent application containing 14 pages of specification, 3 pages of claims and 9 sheet(s) of drawings.
2. ☒ A preliminary amendment is enclosed.
3. ☒ Please amend the specification by inserting the following paragraph after the title:

This application is a continuation of international application serial number PCT/FI99/00566, filed 24 June 1999.

4. ☐ Small entity status
  - a. ☐ A small entity statement is enclosed.
  - b. ☐ A small entity statement was filed in the prior non provisional application.
  - c. ☐ is no longer claimed.

The filing fee is calculated below

CLAIMS				
	Number Filed	Number Extra	Rate	Fee
Total Claims	21		X \$18.00	\$ 18.00
Indep. Claims	4		X \$80.00	\$ 80.00
Multiply Dependent Claims				\$
Basic Fee				\$ 710.00
TOTAL				\$ 808.00

5. ☒ Payment of filing fees  
☐ A check in the amount of \_\_\_\_\_ is enclosed.  
☐ Please charge Deposit Account Number 50-1038.  
☒ Is deferred.
6. ☒ The Commissioner is hereby authorized to credit any overpayment or charge any fees required under 37 C.F.R. §1.16-1.18 to Deposit Account Number 50-1038.
7. ☒ The priority of Finnish application number 981486, filed 26 June 1998, is claimed under 35 U.S.C. §119.  
☒ A certified copy of the priority application is enclosed.
8. ☒ An UNSIGNED Declaration is enclosed.
9. ☐ An assignment of the invention to \_\_\_\_\_, Recordation Form Cover Sheet (Patents Only) and a check in the amount of \$40.
10. ☒ An Information Disclosure Statement, Form PTO 1449 and copies of 4 citations are enclosed.
11. ☒ Correspondence Address
12. ☒ Address all correspondence to Michael B. Lasky.
13. ☒ Also enclosed: Abstract
14. ☒ A return postcard is enclosed.

Altera Law Group  
10749 Bren Road East  
Minneapolis, Minnesota 55343

Respectfully submitted,

Altera Law Group, LLC  
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Minneapolis, MN 55343  
(952) 912-0527

Date: November 1, 2000

By: \_\_\_\_\_

Michael B. Lasky  
Reg. No. 29,555  
MBL/jsc

**PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant:	Wikstedt et al.	Examiner:	UNKNOWN
Serial No.:	TO BE ASSIGNED	Group Art Unit:	TO BE ASSIGNED
Filed:	November 1, 2000	Docket No.:	796.375USW1
Title:	HANDOVER-METHOD IN A CELLULAR RADIO SYSTEM		

CERTIFICATE UNDER 37 C.F.R. 1.10:

'Express Mail' mailing number: EL605624741US

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By: 

Lauren Tran

**PRELIMINARY AMENDMENT**

Box Patent Application  
Assistant Commissioner for Patents  
Washington, D.C. 20231

Dear Sir:

Please enter the following preliminary amendment into the above-referenced application.

**ABSTRACT**

Please insert the attached abstract into the application as the last page thereof.

**SPECIFICATION**

Please amend the specification as follows:

On page 1, in the title, please replace "HANDOVER-METHOD IN A CELLULAR RADIO SYSTEM" with --HANDOVER-METHOD IN CELLULAR RADIO SYSTEM WITH TWO FREQUENCY BANDS--. The title was amended by the International Searching Authority during Chapter 1 of the PCT prosecution. Please see the

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Wikstedt et al.	Examiner:	UNKNOWN
Serial No.:	TO BE ASSIGNED	Group Art Unit:	TO BE ASSIGNED
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By: 

Lauren Tran

PROPOSED AMENDMENT TO DRAWINGS

Assistant Commissioner for Patents  
Washington, D.C. 20231

Dear Sir:

Please enter the following amendment to the drawings into the above-referenced application.

Attached please find new drawings No. 6-9 to be used during Examination. These drawings contain English language text. The published application has Finnish language text on these drawings.

If a telephone conference would be helpful in resolving any issues concerning this communication, please contact Applicant's attorney of record, Michael B. Lasky at 952-912-0527.

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enclosed PCT International Search Report, form PCT/ISA/210, which documents the amendment to the title of the application.

### **CLAIMS**

Please amend the claims as follows:

In claim 5, line 1, please replace "as defined in claim 1 or 4" with --as defined in claim 1--.

In claim 10, line 1, please replace "as defined in any one of claims 1-9" with --as defined in claim 1--.

In claim 15, line 1, please replace "as defined in claim 11 or 14" with --as defined in claim 11--.

### **REMARKS**

The above preliminary amendment is made to insert an abstract page into the application, to amend the title of the application to agree with the amendment to the title made during prosecution of the PCT application and to remove multiple dependencies from the following claims: 5, 10 and 15.

Applicant respectfully requests that this preliminary amendment be entered into the record prior to calculation of the filing fee and prior to examination and consideration of the above-identified application.

If a telephone conference would be helpful in resolving any issues concerning this communication, please contact Applicant's attorney of record, Michael B. Lasky at 952-912-0527.

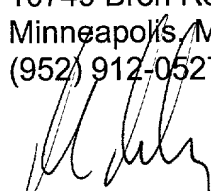
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## HANDOVER-METHOD IN A CELLULAR RADIO SYSTEM

### Field of the invention

The invention concerns a handover-method in a cellular radio system, especially in a system of two or more frequency bands, wherein there is only one broadcast channel.

### Background of the invention

Figure 1 shows a simplified block diagram of the GSM system (Global System for Mobile communications). Mobile station MS is connected over a radio path with some base transceiver station BTS, in the case shown in Figure 1 with base transceiver station BTS1. Base Station Sub-system BSS includes Base Station Controller BSC and subordinated base transceiver stations BTS. Several base station controllers BSC are usually subordinated to Mobile Services Switching Centre MSC. Mobile services switching centre MSC is in connection with other mobile services switching centres, and through Gateway Mobile Services Switching Centre GMSC the GSM network is connected with other networks, such as public switched telephone network PSTN, another public land mobile network PLMN, ISDN network or intelligent network IN. The operation of the whole system is monitored by Operation and Maintenance Centre OMC. The subscriber information of mobile station MS is permanently stored in the system's Home Location Register HLR and it is temporarily stored in that Visitor Location Register VLR, in the area of which mobile station MS is located at each time. Location information of the mobile station is stored in visitor location register VLR with Location Area LA precision. The geographical area monitored by the visitor location register is divided into one or more location areas. One or more base transceiver stations BTS may operate in each location area. Each base transceiver station BTS is constantly transmitting such information on its broadcast channel which is intended for all mobile stations MS and which contains Base Station Identity Code BSIC, location area identifier LAI and information about such frequencies of adjacent base transceiver stations which mobile station MS should measure.

In mobile communications systems of the cellular type, radio coverage is implemented with several radio cells which are located with some mutual overlapping. The mobile station may move freely in the area of



the mobile station network and may connect with the best base transceiver station signal available at each time. When the mobile station moves from one cell to another during a call, handover to a new radio cell is performed based on predetermined handover criteria. Handover should be carried out in a way causing the least possible interference with the call going on. To make it possible in a mobile communications system to find out the need for handover and to choose a suitable target cell for the handover, various measurements of connection quality are needed as well as measurements of the field strengths of adjacent cells. Handover is normally caused due to criteria of the radio path, but it can be done also for other reasons, such as e.g. in order to divide the load or to reduce transmission powers. Handover may also be carried out inside the cell from one traffic channel to another.

Mobile station MS is constantly measuring the broadcast channel signals of those base transceiver stations BTS which are located closest to itself, e.g. in order to determine the base transceiver station providing the best signal and to prepare for a possible exchange of cell. Based on the adjacent cell information transmitted by each base transceiver station on its broadcast channel, the mobile station will identify those adjacent cells which it should watch. Mobile station MS regularly transmits the measurement results as a report message through serving base transceiver station BTS1 to base station controller BSC. The report message contains the measurement results of the serving base transceiver station and of no more than the six best adjacent base transceiver stations. Base transceiver station BTS performs signal level and quality measurements of all radio connections going on at the base transceiver station.

Handover from a serving cell to some neighboring cell or to another channel of the serving cell may take place e.g. when measurement results of the mobile station and/or the base transceiver station indicate a low signal level and/or quality in the current channel of the serving cell and a better signal level is available from an ambient cell or a better signal quality can be achieved on another channel, or when some ambient cell/other channel allows communication at lower transmission power levels. The choice of target cell for the handover is influenced e.g. by the signal level and/or load of the target cell. Generally used handover criteria are thus e.g. the signal level and quality of the radio connection, the signal levels of the initial cell and the target cell, the signal level of the initial cell, the

transmission power which is demanded of the mobile station and which is permissible for the mobile station in the target cell. Handover from one traffic channel to another is usually carried out when handover criteria established by the operator are fulfilled. It may be necessary to perform handover also

5 due to excessive loading.

Base station controller BSC makes the decisions relating to handover. If the target cell is subordinated to another base station controller BSC, the handover may be done under the control of mobile services switching centre MSC. Handover decisions can also always be made

10 centrally in mobile services switching centre MSC. When required, base station controller BSC gives a handover command through the base transceiver station to mobile station MS.

Figure 2a illustrates signalling relayed in handover between transceiver units TRX of two base transceiver stations in the GSM network.

15 In the start-up situation of the handover in Figure 2a, a radio communication has been set up for mobile station MS, e.g. in order to transmit speech, data or signalling, by way of initial TRX. When base station controller BSC finds that there is a need for handover to a channel of another base transceiver station, base station controller BSC will transmit to target-TRX Channel activation message 21, notifying of the need for handover and requesting

20 target-TRX to assign a radio channel for the mobile station. The target TRX assigns a radio channel for communication and notifies base station controller BSC of this in Channel activation ack message 22. Base station controller BSC transmits the new radio channel information to the initial-TRX

25 of the base transceiver station now to be used in a Handover command (message 23). The base transceiver station transmits the radio channel information to mobile station MS in a Handover command message 24. Mobile station MS carries out the handover by moving over to the new indicated radio channel and transmits to target-TRX a connection request in

30 Handover access burst message 25. Mobile station MS transmits these Handover access burst messages at certain intervals, until it receives a reply from the base transceiver station. Having received the connection request of mobile station MS, the target-TRX transmits to the mobile station an acknowledgement in Physical info message 31, also stating e.g. the timing

35 advance needed by the mobile station for its transmission. Then a link connection is set up between mobile station MS and target-TRX of the new

base transceiver station by messages 32 SABM and 33 UA. After the link connection has been set up, mobile station MS transmits to target-TRX an acknowledgement of the successful performance of the handover in Handover complete message 34. The information about successful  
5 handover is relayed to base station controller BSC in Handover complete message 35. Mobile station MS continues its communication via the target-TRX. The handover initial-TRX and target-TRX may also be located in the same base transceiver station. If the initial-TRX and the target-TRX are located subordinated to different base station controllers, the signalling will  
10 be relayed through mobile services switching centre MSC.

Handover will fail at times due to interference on the radio path. Figure 2b illustrates signalling in a situation where handover has failed. As regards messages 21-25, the handover begins in the same way as was described earlier in connection with Figure 2a. However, if mobile station MS  
15 receives no reply to its connection requests (messages 25) within a certain time established in advance, after the base transceiver station has failed to receive the connection requests or after the mobile station has failed to receive the base transceiver station's acknowledgement of the connection requests, mobile station MS will return to that channel of the initial-TRX, from  
20 which the handover started. A link connection is set up between mobile station MS and the initial-TRX by messages 36 SABM and 37 UA. After the link connection has been set up, mobile station MS transmits to the initial-TRX a message of the failure of the handover in a Handover failure message 38. Information about the handover failure is relayed to base  
25 station controller BSC in Handover failure message 39. Mobile station MS continues its communication via the initial-TRX.

Figure 2c shows a signalling diagram of handover during a call in handover within a cell from an initial channel to a target channel. When base station controller BSC finds that there is a need for handover, it transmits to  
30 the target channel a channel assignment request in a Channel activation message 21 in the same way as was described earlier in connection with Figure 2a. Also the acknowledgement and the notification of radio channel data in message 22 are transmitted in the way described in connection with Figure 2a. Base station controller BSC transmits to the initial channel now to  
35 be used for communication new radio channel data in Assignment command message 23, which is relayed further to mobile station MS in

message 24. After mobile station MS has received the assignment command to a new channel, it transmits on target channel a message 32 to set up a SABM link connection. The base transceiver station acknowledges this with message 33 UA. To complete the handover, the mobile station transmits on the new channel a message of the successful channel assignment in Assignment complete message 34. The base transceiver station relays this information further to the base station controller in Assignment complete message 35.

Figure 2d is a signalling diagram of a failed handover within a cell during a call. Messages 21-24 and 32 are transmitted in the same way as has been described above in connection with Figure 2c. The handover within the cell fails after the base transceiver station has failed to receive the link connection set up message or after the mobile station has failed to receive the base transceiver station's acknowledgement of the set up of the link connection. Having waited for the reply for a certain time, mobile station MS transmits to the network a message of the failed channel assignment in Assignment failure message 38 on that initial channel from which handover began. The base transceiver station relays the message of the failed channel assignment to base station controller BSC in Assignment failure message 39.

In a mobile communications system implemented with Code Division Multiple Access (CDMA) technology, such handover which is carried out in the ways described above is called hard handover. In addition, CDMA systems use so-called soft handover, where in the course of handover the mobile station may be simultaneously connected with the network through several base transceiver stations. When the signal of some station of these base transceiver stations shows this station to be the best, the mobile station's connections with other base transceiver stations are cut off and the call is continued only through this one base transceiver station which is best. Soft handover prevents handover back and forth between base transceiver stations, when the mobile station is located in a marginal area of the cells.

In cellular radio systems of two different frequency ranges, handover from one frequency range to another is a bit more problematic, especially so when there is only one broadcast channel in the cellular radio system. E.g. in a combination of a GSM system operating in a frequency band of approximately 900 MHz and a DCS system operating in a frequency

band of approximately 1800-1900 MHz one broadcast channel can be implemented e.g. in a GSM frequency range. Hereby mobile station MS is able to measure only the base transceiver station signals of the transmission at GSM frequency. Hereby the call set up is always begun from the frequency range of the broadcast signal, because the broadcast is needed for synchronising the mobile station into the network, and during the call handover is attempted to another frequency range. It is known in the case of one broadcast channel to perform handover between GSM and DCS frequencies in two different ways: 1) by setting in the handover criterion a sufficiently high threshold value, which the broadcast signal must meet before handover will be carried out to another frequency range, or 2) by putting in test use a traffic channel of another frequency range, whereby normal uplink and downlink measurements are made on the traffic channel during the call and a new handover is performed back to the first frequency range, if the signal is not good enough. In the second method presented above, the criterion for performing handover to another frequency range may be set as a lower value than in the first method, e.g. as an average value.

It is a problem in state-of-the-art methods of implementing handover, and especially in a cellular radio system of two frequency ranges presented above, in the first method that a safe handover threshold value is uneconomic from the viewpoint of network capacity, whereby it wastes network capacity. Since the range of a base transceiver station signal of a larger frequency range is smaller than the range of a base transceiver station signal of a smaller frequency range and signals of different frequencies will change at a different rate in relation to the distance, the safe handover threshold value must be made even too demanding e.g. as regards handover taking place near the base transceiver station. In addition, such a safe threshold value will prevent full utilisation of another frequency range in the communication. In the second method of implementation presented above, it is a problem that the connection quality will deteriorate in the other frequency range while measurements are performed on the traffic channel, if the radio signals are not good enough after all and a new handover must be performed in order to move the connection back to the first frequency range. The quality of the service will then suffer, as the mobile station is exposed to the poor radio signal.

### Summary of the invention

The objective of this invention is to bring about a handover-method which saves resources of a cellular radio system, especially in systems of several frequency bands, wherein there is only one broadcast  
5 channel.

This objective is achieved with the methods according to the invention, which are characterised by that which is said in the independent claims. Advantageous embodiments of the invention are presented in the dependent claims.

10 The invention also concerns a mobile communications system and a base transceiver station.

The invention is based on the idea that after handover has started, that signal is measured which is received at the base transceiver station from the mobile station in connection with handover signalling, and  
15 handover is allowed to continue only if the mobile station's signal meets a criterion established beforehand. Completion of handover thus depends on the uplink signal received at the base transceiver station. The communication on the connection is not transferred to a new channel, if during handover signalling it is found at the base transceiver station that the  
20 mobile station's signal does not meet the established criterion, but hereby the connection is continued on the old channel, from which handover started.

It is an advantage of such a method and mobile communications system implementing the method that the efficiency and capacity of the cellular radio system will increase, when the acceptance of the handover  
25 target cell is based on real radio measurements. An improved channel management is thus achieved by the method according to the invention.

Another advantage attained by the handover in accordance with the invention is that network capacity is saved as regards measurements and radio path resources are saved as the channel is not assigned for operation  
30 for an unnecessarily long time.

In addition, it is an advantage of handover according to the invention that the quality of service remains good also in connection with handovers.

### Brief description of the drawings

35 The invention will now be described in connection with preferred

embodiments and referring to the examples shown in Figures 3-8 in the appended drawings, wherein :

- 5 Figure 1 shows such parts of a mobile communications network which are essential to the invention;
- Figures 2a - 2d show state-of-the-art handover signalling;
- Figure 3 shows an example of a part of the radio coverage of a cellular radio system having two frequency ranges;
- 10 Figure 4 shows a flow chart of a handover-method in accordance with the invention;
- Figure 5 shows handover signalling in handover between two signals in a first embodiment of the invention;
- Figure 6 shows handover signalling in intracellular handover in a first embodiment of the invention;
- 15 Figure 7 shows handover signalling in handover between two cells in a second embodiment of the invention ; and
- Figure 8 shows a block diagram of the structure of a base transceiver station according to the invention as regards those parts which are essential to the invention.
- 20

### Detailed description of the invention

The present invention can be applied in connection with any kind of mobile communications system. Hereinafter the invention will be described in greater detail by way of example, primarily in connection with  
25 the digital GSM-DCS mobile communications system, which operates with two frequency bands. Figure 1 shows the simplified structure of the GSM network which was described above. As regards a more detailed description of the GSM system, reference is made to the GSM recommendations and to the book "The GSM System for Mobile Communications", M. Mouly & M.  
30 Pautet, Palaiseau, France, 1992, ISBN:2-9507190-0-7.

In the following, the invention will be described in greater detail in the light of a first embodiment of the invention and with reference to Figures 3-6.

35 Figure 3 shows the cellular coverage of two base transceiver stations BTS1 and BTS2 in a cellular radio system having two frequency bands. Cell coverages C1 and C2 represent the GSM cells of the lower

frequency range, while cell coverages C3 and C4 represent the DCS cells of the higher frequency range, which have a smaller coverage area than the GSM cells. When mobile station MS is moving in the cellular system during a call or a data transmission, the need for handover of the connection is monitored in a state-of-the-art fashion based on signal measurements supplied by the mobile station to the network and performed by the base transceiver station. E.g. when mobile station MS has reached the area of cell C3, handover is started from the transceiver unit TRX1 of cell C1 to the transceiver unit TRX3 of cell C3 (not shown in the figure). The handover to be performed in accordance with the invention is described more closely in the following referring to the flow chart in Figure 4.

At stage 41 in Figure 4 handover is started e.g. from a channel of the first frequency range to a channel of the other frequency range, in the case shown as an example in Figure 3 from the channel of TRX1 to the channel of TRX3. According to the invention, TRX3 measures a signal of the handover signalling transmitted by the mobile station (stage 42) and compares the signal with a pre-established criterion (stage 43). If the signal of mobile station MS meets the established criterion, handover will be continued in a state-of-the-art fashion and the radio connection of the mobile station is transferred for relaying through TRX3 (stage 44). If the signal of mobile station MS does not meet the established criterion, handover is interrupted and relaying of the mobile station's radio connection will continue through TRX1 (stage 45).

Figure 5 is a signalling diagram in greater detail of handover between two cells in accordance with the invention. The initial-TRX preferably uses the frequency range channel of the broadcast channel while the target-TRX uses a channel of the other frequency range. Handover is started in a state-of-the-art fashion when a criterion is fulfilled which is established for handover to be performed from a first frequency range to a second frequency range. Handover begins with base station controller BSC sending to the target-TRX a channel assignment request in a Channel activation message 51. Besides the state-of-the-art information, message 51 may be used in accordance with the invention for relaying to the target-TRX the information that the started handover is a conditional handover in accordance with the invention. Message 51 can also be used for supplying to the mobile station's MS signal that criterion, the fulfilment of which is the



precondition for continuation of the handover. Alternatively, the criterion for continued handover may be supplied to the base transceiver station in an O&M procedure. In a state-of-the-art fashion, target-TRX assigns a radio channel for communication and makes this known to base station controller

5 BSC (message 22), which sends the new radio channel information to the initial-TRX (message 23). Further, in a state-of-the-art fashion, the radio channel information is transmitted to mobile station MS (message 24). Mobile station MS performs the handover by moving over to the new indicated radio channel and it transmits to the target-TRX a state-of-the-art

10 connection request in a Handover access burst message 25. Mobile station MS sends these connection request messages at certain intervals, until it receives a reply from the base transceiver station. In accordance with the present invention, at stage 55 target-TRX measures the radio signal of the Handover access burst message 25 it received from the mobile station. From

15 this radio signal, the base transceiver station measures the value/values required by the criterion established for the signal. According to the invention, the base transceiver station compares the measurement results with the established criterion. If the mobile station signal meets the pre-established criterion, handover will be continued after stage 57 in a state-of-

20 the-art fashion with acknowledgement by the base transceiver station (message 31). Thereupon, the handover signalling is still carried on in a state-of-the-art fashion also as regards messages 32-35. The communication between mobile station MS and the network is continued through the target-TRX. If judging by the measurement performed at stage

25 55 the mobile station signal does not meet the pre-established criterion, the process according to the invention continues from stage 55 to stage 59 in the signalling diagram. Hereby the base transceiver station will not send any acknowledgement message to the mobile station, so in a state-of-the-art fashion mobile station MS after a certain time sends message 36 to target-

30 TRX to set up a link connection in the same way as in a state-of-the-art situation of failed handover. Messages 37-39 are also similar to a state-of-the-art situation of failed handover. In this situation, the communication will be continued through initial-TRX.

Figure 6 is a signalling diagram of handover in accordance with a

35 first embodiment of the invention in intracellular handover from the initial channel to the target channel during a call. When handover has started

based on a state-of-the-art criterion, base station controller BSC transmits to the target channel a channel assignment request in a Channel activation message 51, in which it is possible in accordance with the invention to relay the information that the started handover is a conditional handover in accordance with the invention, and preferably also the criterion established for this conditional handover. Alternatively, the criterion for continued handover may be supplied to the base transceiver station in an O&M procedure. In a state-of-the-art fashion, the target channel is assigned for communication with the mobile station, and this is made known to base station controller BSC (message 22), which sends information about the assigned radio channel to the initial channel (message 23). Further, in a state-of-the-art fashion the radio channel information is transmitted to mobile station MS (message 24). Mobile station MS performs the handover by moving over to the new indicated radio channel and it transmits on the target channel state-of-the-art SABM message 32. In accordance with the present invention, the base transceiver station at stage 65 measures this signal and compares the measurement results with the established criterion. If the signal received from the mobile station meets the established criterion, the handover will be continued from stage 67 with an acknowledgement sent by the base transceiver station in UA message 33. The successful channel assignment is made known in a state-of-the-art fashion in messages 34 and 35. The communication between mobile station and network is continued on the target channel. If the comparison at stage 65 indicates that the signal received from the mobile station does not meet the established criterion, signalling is continued in accordance with the invention after stage 65 from stage 69. Hereby the base transceiver station will not send any acknowledgement signal to the mobile station, and after waiting for a certain time the mobile station will send to the network a message that the channel assignment failed in Assignment failure message 38 on the initial channel from which the handover started. The information about handover failure is transmitted in a state-of-the-art fashion to base station controller BSC in message 39. The communication between mobile station and network is continued on the initial channel. The initial channel and the target channel shown in Figure 6 are preferably in the second frequency range of the system, where there is no broadcast channel.

Figure 7 shows handover signalling in accordance with a second

embodiment of the invention in handover between two cells. This embodiment is otherwise similar to the first embodiment described above in connection with Figure 5, except as regards the first message after rejection of the handover. In this embodiment, the target-TRX transmits to mobile station MS a message of the handover rejection in Physical info message 5 71, which is known as such in the art, which is thus in this situation used in a new context and with a new information content. It is an advantage of this embodiment that mobile station MS receives information more quickly about the handover failure and it then knows to go back to its former channel, when 10 the base transceiver station notifies the mobile station of the negative result of measurements and of its comparison in message 71, instead of the mobile station transmitting connection requests and waiting for a certain state-of-the-art time before it finds out that the handover has failed. For this embodiment to work, changes must be made in the network and slight 15 changes must also be made in the mobile station.

Intracellular handover in accordance with the second embodiment of the invention is implemented in a similar manner. Thus, the handover signalling hereby differs from that shown in Figure 6 only as regards the signalling after a rejected handover (stage 69), so that on the target channel 20 information about rejection of the handover is transmitted to the mobile station in the Physical info message.

The handovers presented above may of course also be implemented between channels subordinated to two different base station controllers BSC. Hereby the handover signalling will travel through mobile 25 services switching centre MSC.

The handover-method according to the invention is also suitable for use in a cellular radio system having one frequency range or otherwise in handovers within the same frequency range, although the greatest benefit is achieved with the invention in a system having several frequency ranges, 30 wherein only one broadcast channel is used. In handovers within one frequency range, the method according to the invention may be used for carrying out a quick handover, e.g. when judging by measurement results the suitability of the target channel is uncertain.

The criterion according to the invention which was presented 35 above and which is established for continued handover may be a fixed criterion established by the operator, a criterion generated as a derivative of

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radio parameters stored in the network or e.g. a criterion which changes dynamically with the interference level of the network and which will settle at its current value based on idle channel measurements. The established criterion may include one or more threshold values e.g. for the signal level  
5 and/or for the signal-to-interference ratio and/or for other suitable state-of-the-art handover criteria.

A mobile communications system implementing the method according to the invention is adapted to start conditional handover, to supply a criterion for the conditional handover to the base transceiver station, to  
10 measure the signal of the mobile station's handover signalling at the base transceiver station, to compare the measurement results with a pre-established criterion and to interrupt handover, when it is found as a result of the comparison that the mobile station signal does not meet the pre-established criterion.

Figure 8 is a block diagram of a base transceiver station according to the invention. The figure shows only those parts which are essential for the invention. The base transceiver station includes state-of-the-art handover-signalling unit 81 for controlling the handover signalling. According to the present invention, the base transceiver station includes signalling  
20 measuring means 82 for measuring the signal of the handover signalling received from the mobile station and comparison means 83 for comparing the measurement results of the measuring means with a pre-established criterion K for conditional handover in accordance with the invention. The base transceiver station receives criterion K from elsewhere in the network,  
25 e.g. from base station controller BSC. As a result of the comparison performed by comparison means 83, a control signal is obtained for controlling the function of handover-signalling unit 81.

The drawings and the relating explanation are only intended to illustrate the inventive idea. As regards its details the handover according to  
30 the invention may vary within the scope of the claims. Although the invention was explained above mainly in connection with a system of the TDMA type, the method may also be used in another kind of cellular radio system, e.g. in a CDMA system and both in hard and soft handover. The invention is suitable for use in all kinds of intracellular handover and handover between  
35 cells, wherein there is an initial channel to which the connection can be returned. By handover according to the invention the use of channels of a

- frequency range without broadcasting is made more effective and the usefulness of internal handovers of such a frequency range is improved. Although the above description of the invention was presented mainly in connection with a cellular radio system having two frequency ranges, the
- 5 invention is suitable for use also in cellular systems having one frequency range and more than two frequency ranges. The invention is especially advantageous in such cellular radio systems, where the broadcast signal is not implemented on all frequency ranges to be used.

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1. Handover-method in a cellular radio system including base transceiver stations (BTS) and mobile stations (MS), in which cellular radio system at least two frequency bands are used, and wherein each base transceiver station transmits a broadcast intended for all mobile stations in a first frequency range, in which method handover to the second frequency range is started, c h a r a c t e r i z e d in that

the measurement results are compared with a pre-established criterion, and

2. Method as defined in claim 1, characterized in that

the communication between mobile station and network is continued on the initial channel, from which the handover started.

4. Method as defined in claim 1, characterized in that the signal level of the mobile station's bursts is measured.

6. Method as defined in claim 1, c h a r a c t e r i z e d in that a pre-established criterion (K) is transmitted to the base transceiver station in connection with the channel assignment signalling (51).

8. Method as defined in claim 1, characterized in that on a new channel assigned for the connection the bursts of connection request signalling (25) received from the mobile station are measured at the base transceiver station.

9. Method as defined in claim 1, characterized in that the bursts of link connection set up signalling (32) received from the mobile station are measured at the base transceiver station.

10. Method as defined in any one of claims 1-9, characterized in that the first frequency range is a frequency range of a lower frequency than the second frequency range.

11. Handover-method in a cellular radio system including base transceiver stations (BTS) and mobile stations (MS), in which method handover from an initial channel to a target channel is started, characterized in that

bursts transmitted by the mobile station (MS) and relating to the handover

signalling are measured at the base transceiver station (BTS), the measurement results are compared with a pre-established criterion, and

handover is completed only when the criterion is met.

12. Method as defined in claim 11, characterized in that the handover is interrupted, when the established criterion is not met, and

the communication between the mobile station and the network is continued on the initial channel, from which handover started.

13. Method as defined in claim 12, characterized in that the mobile station (MS) is notified of the handover interruption.

14. Method as defined in claim 11, characterized in that in

the method the signal level of the mobile station's bursts is measured.

15. Method as defined in claim 11 or 14, characterized in that the signal-to-noise ratio of the mobile station's bursts is measured.

16. Method as defined in claim 11, characterized in that a pre-established criterion (K) is transmitted to the base transceiver station in connection with the channel assignment request signalling (51).

17. Method as defined in claim 11, characterized in that the pre-established criterion (K) is transmitted to the base transceiver station in an O&M procedure.

18. Method as defined in claim 11, characterized in that on the target channel the bursts of the connection request signalling (25) received from the mobile station are measured at the base transceiver station.

19. Method as defined in claim 11, characterized in that the signal of the link connection set up signalling (32) received from the mobile station is measured at the base transceiver station.

20. Mobile communications system including base transceiver stations (BTS) and mobile stations (MS), characterized in that the mobile communications system is adapted

to start a conditional handover and to supply a criterion (K) for the conditional handover to the base transceiver station,

to measure the signal of the mobile station's (MS) handover signalling at the base transceiver station (BTS),

to compare the measurement results with the pre-established criterion (K), and

to interrupt the handover, when the mobile station signal as a result of the comparison does not meet the pre-established criterion.

21. Base transceiver station including a handover-signalling unit (81) for controlling the handover signalling, characterized in that the base transceiver station also includes

measuring means (82) for measuring the signal of the handover signalling received from the mobile station (MS), and

comparison means (83) for comparing the measurement results of the measuring means with the pre-established criterion (K) for continuation of handover, whereby as a result of the comparison a control signal is obtained for the handover-signalling unit (81).



## **ABSTRACT**

**For**

### **HANDOVER-METHOD IN A CELLULAR RADIO SYSTEM**

Handover in a cellular radio system having several frequency ranges is problematic e.g. from the viewpoint of network capacity utilisation. The invention concerns a handover-method, especially in a cellular radio system having at least two frequency ranges, wherein broadcasting is transmitted in a first frequency range and handover to a second frequency range is started. The method according to the invention is characterised in that bursts transmitted by the mobile station (MS) and relating to the handover signalling are measured therein at the base transceiver station (BTS), the measurement results are compared with a pre-established criterion and handover is completed only when the criterion is met.

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Fig. 1

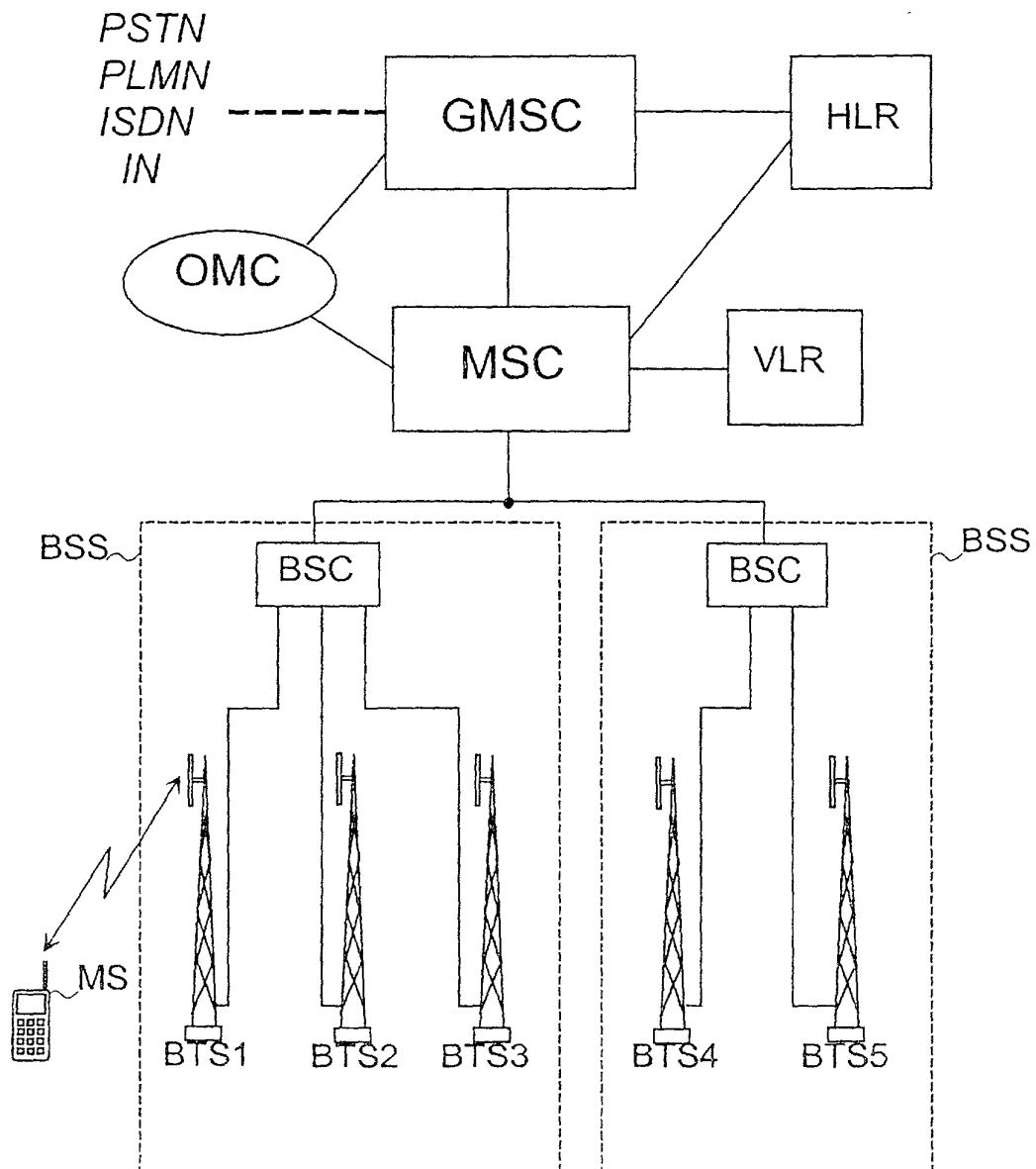
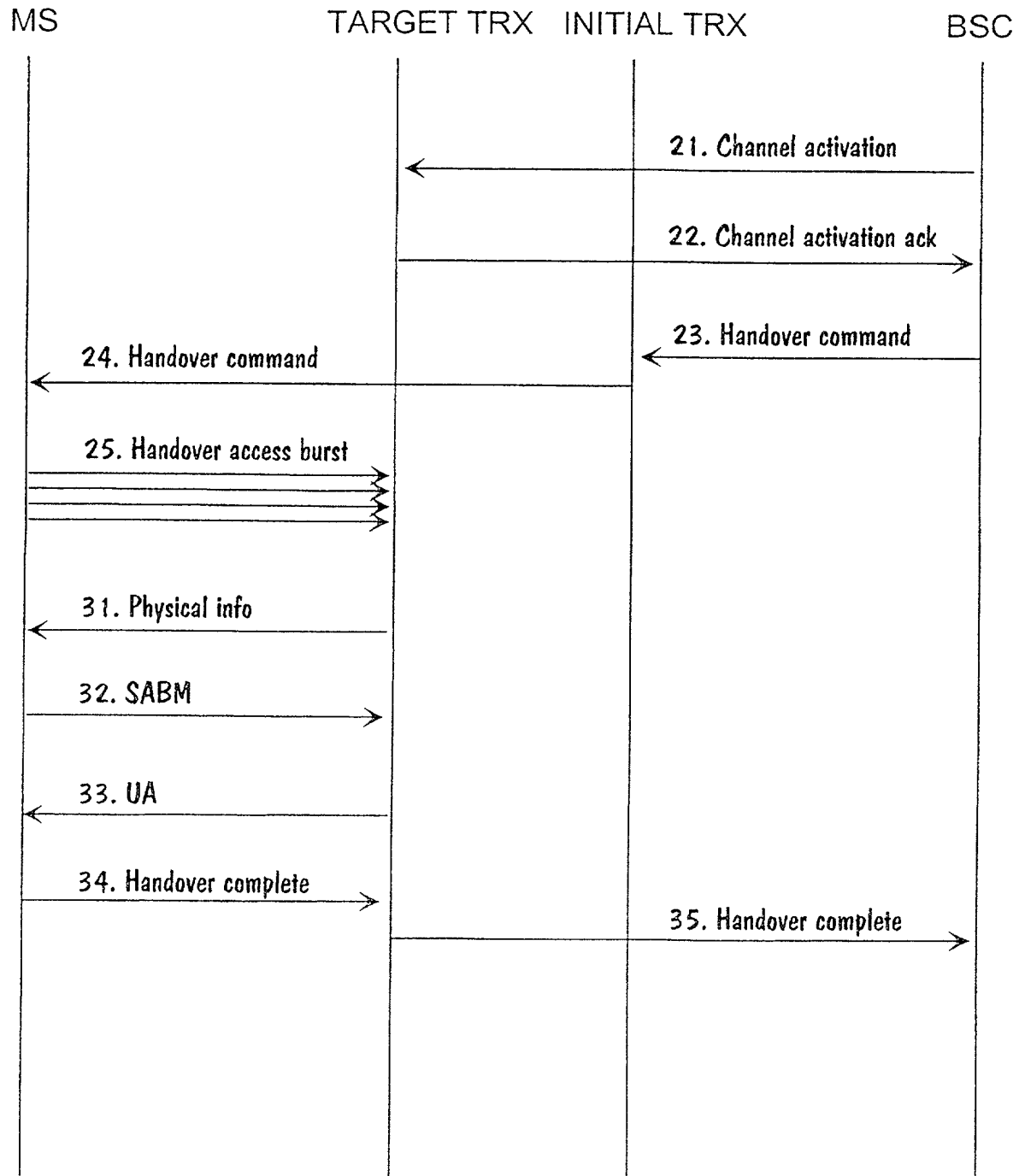
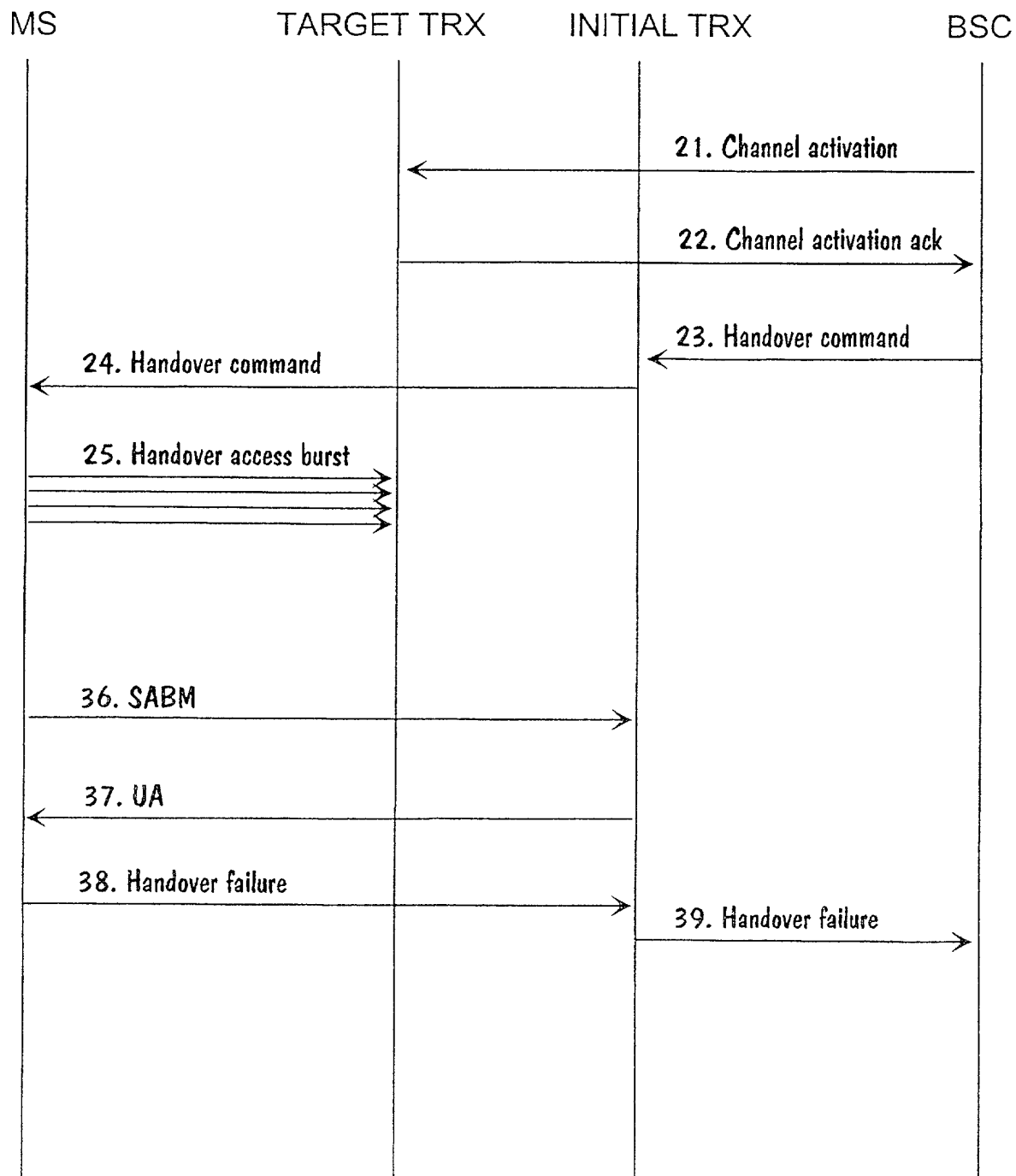


Fig. 2a



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Fig. 2b



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Fig. 2c

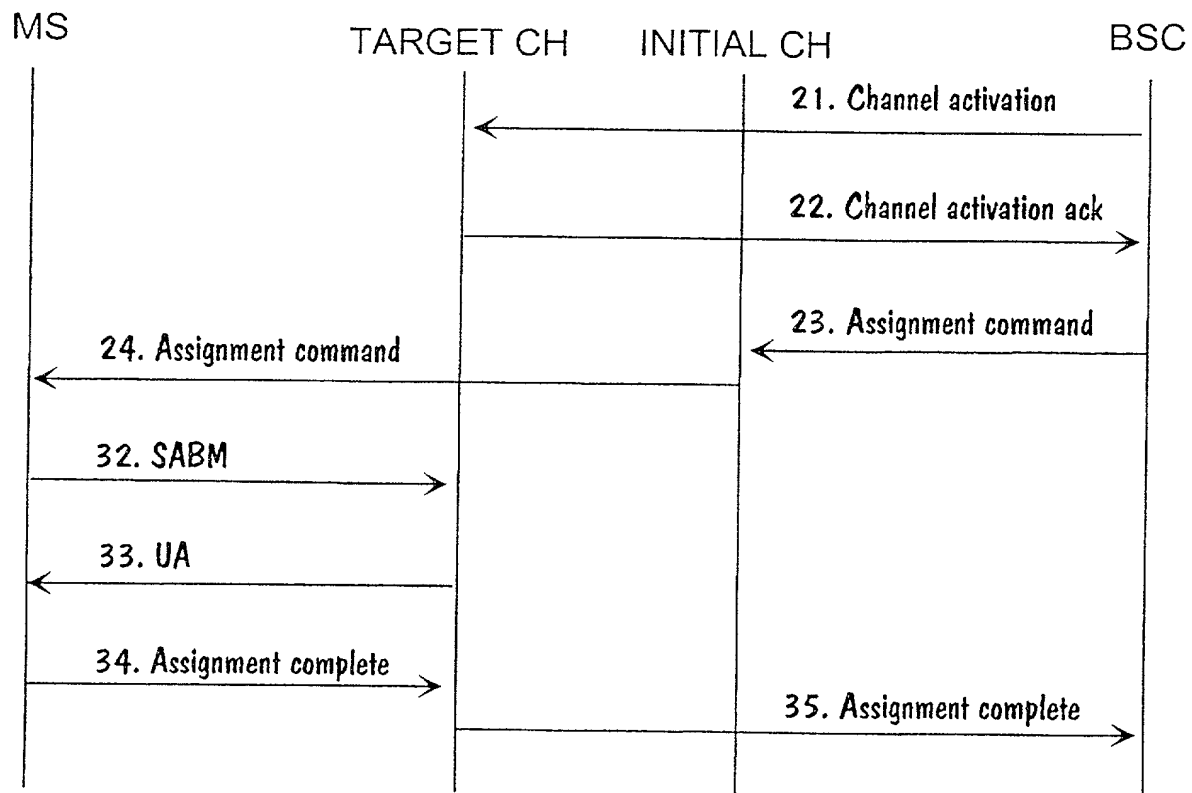


Fig. 2d

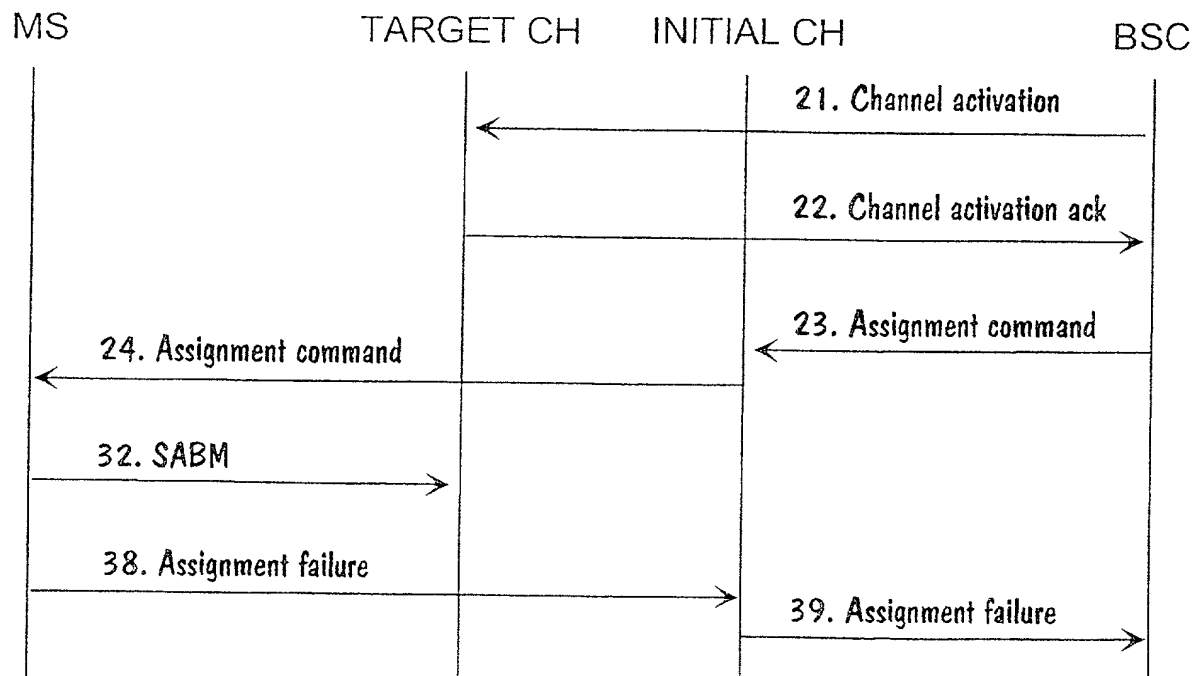


Fig. 3

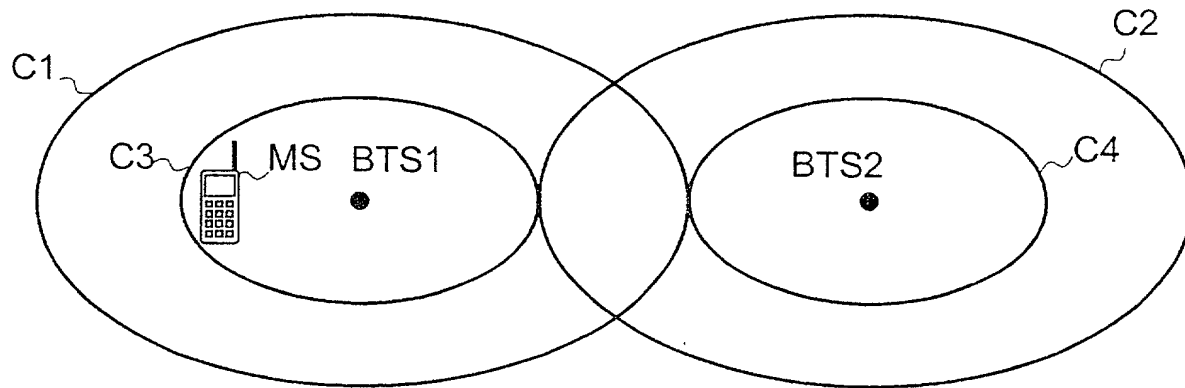


Fig. 4

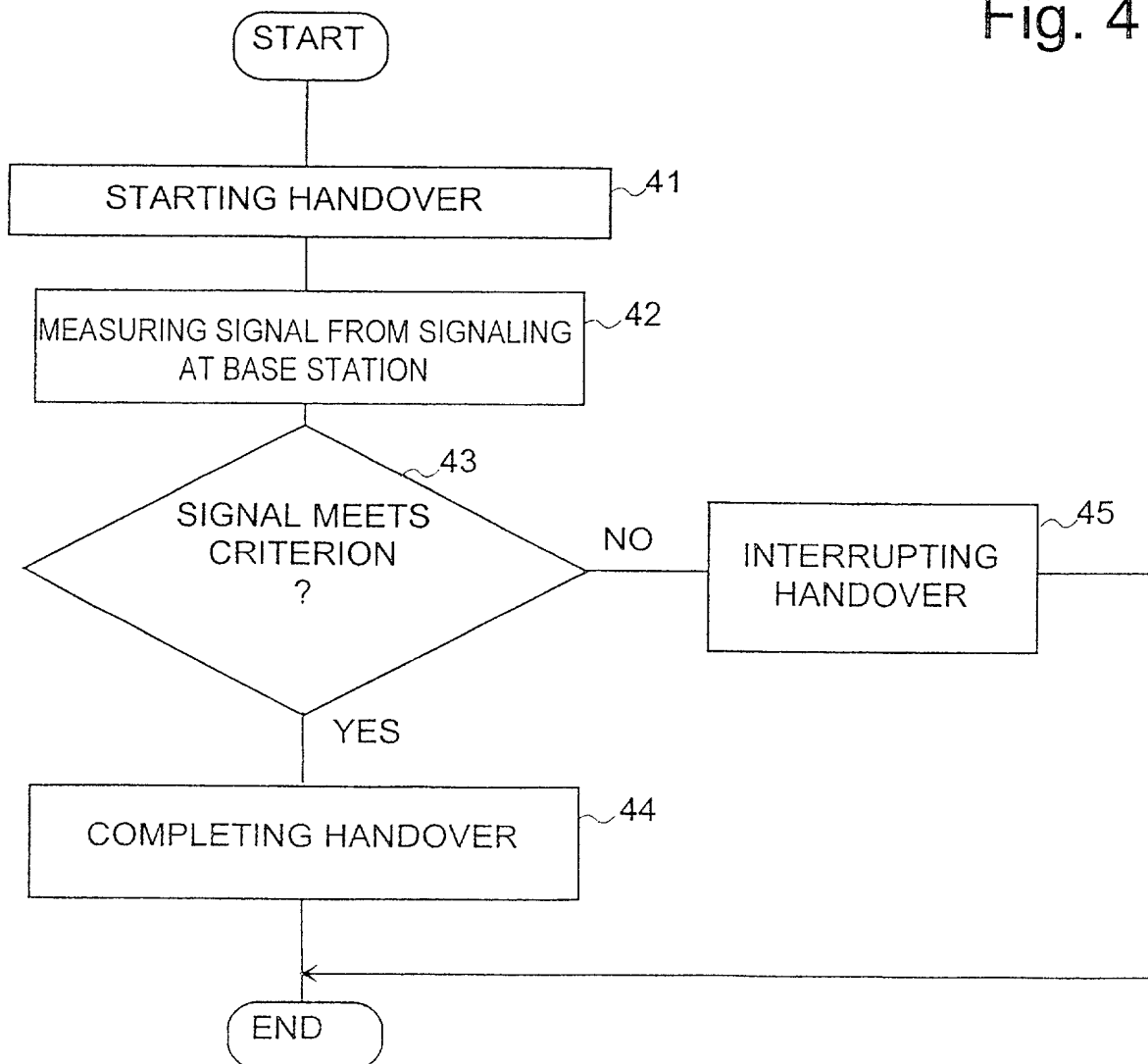
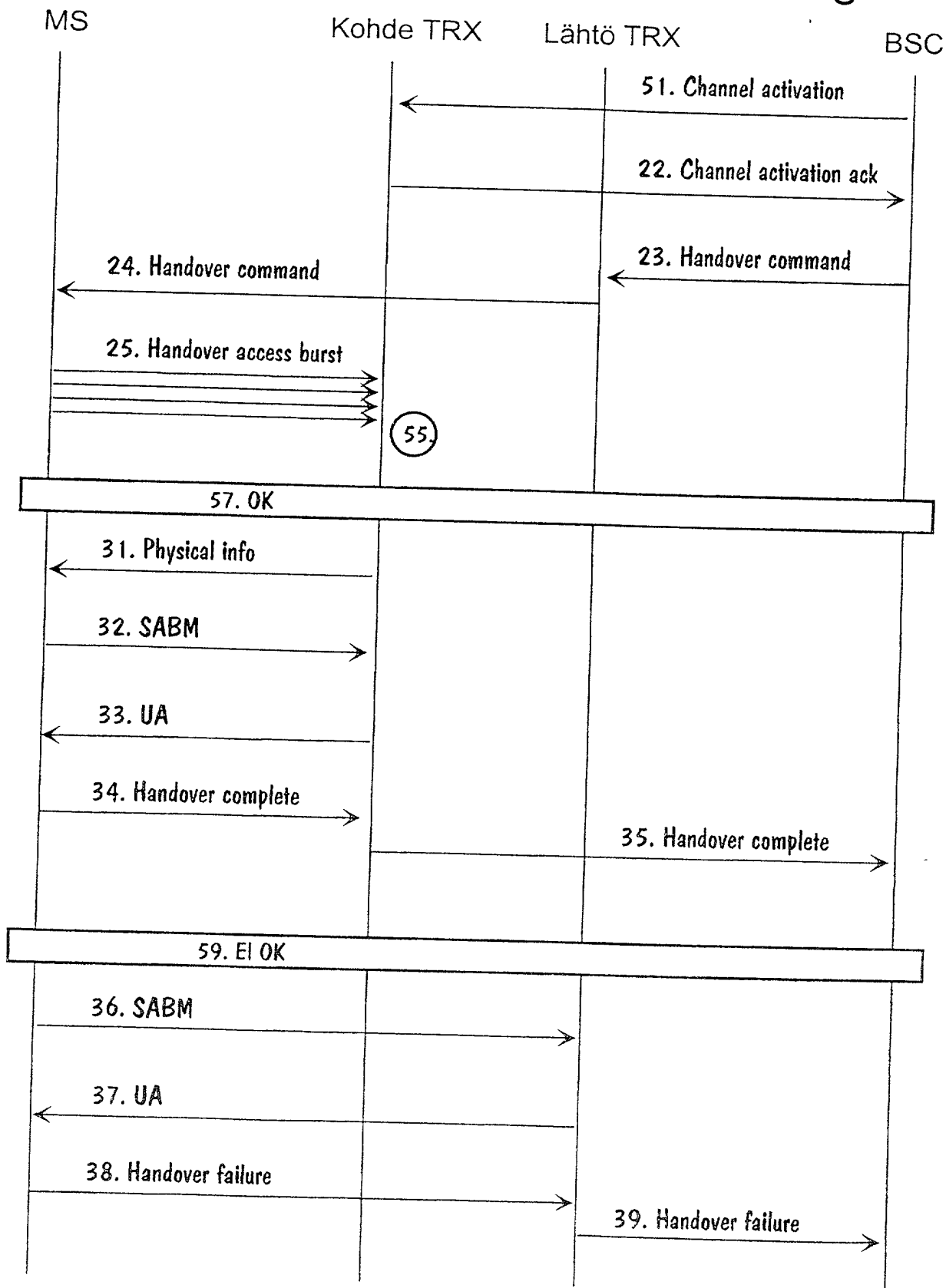
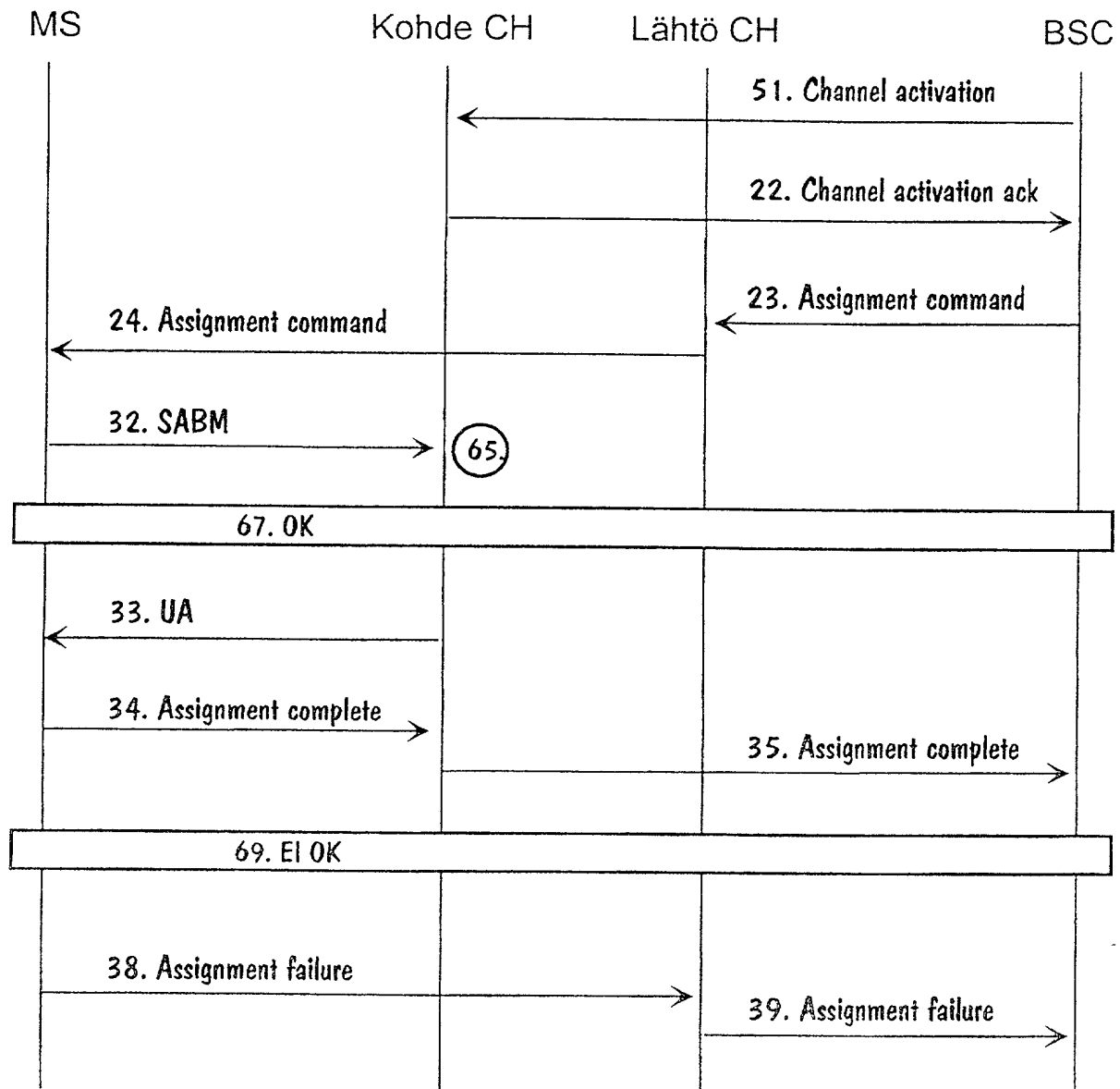


Fig. 5



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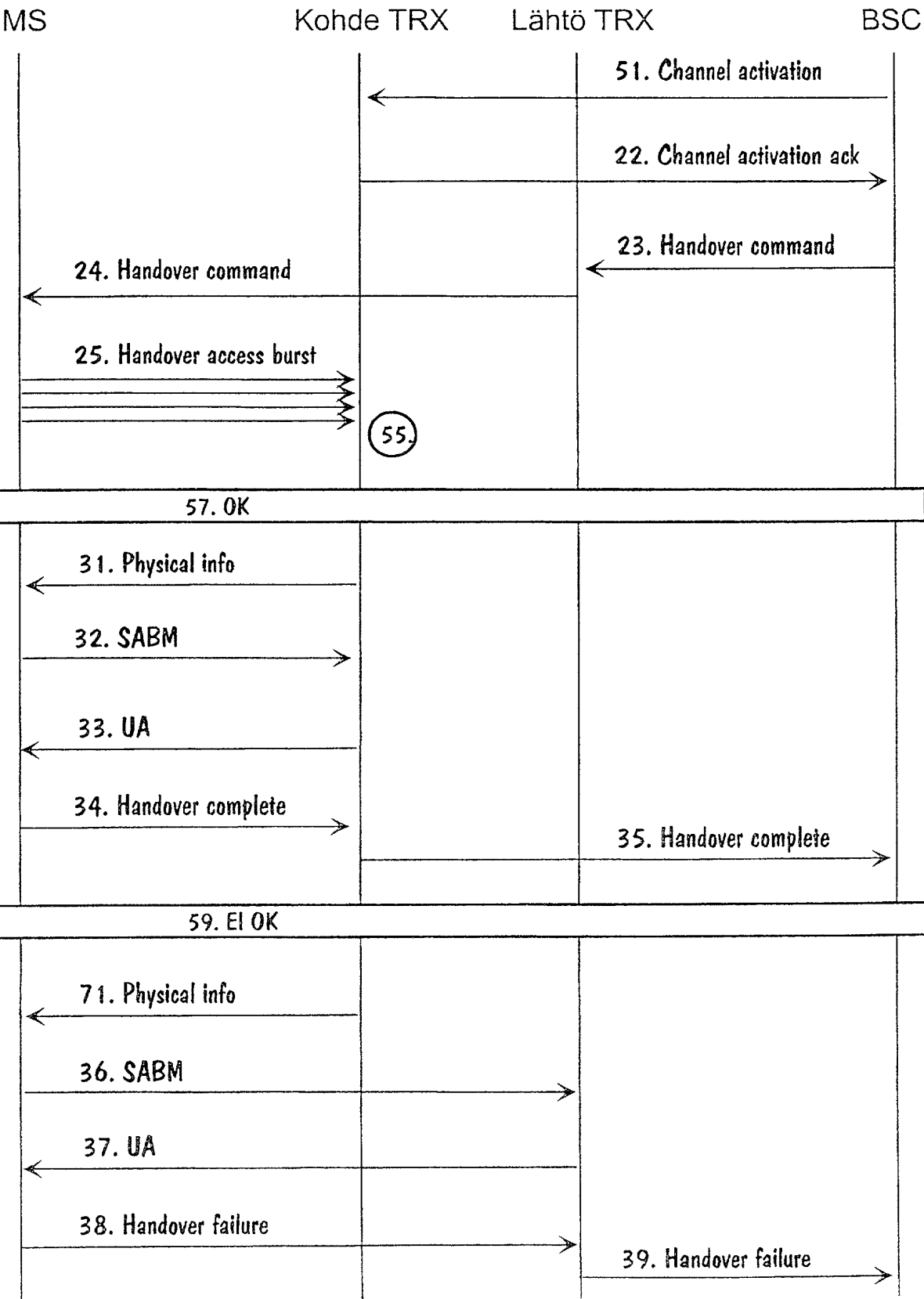
Fig. 6



Variable	Mean	SD	Min	Max
Age (years)	35.2	12.5	18	65
Gender (Male/Female)	15/15	0	0	30
Marital status (Married/Single)	10/10	0	0	20
Education level (High school/College/Postgraduate)	10/10/0	0	0	20
Occupation (Student/Teacher/Engineer/Doctor/Lawyer/Artist/Musician/Writer/Actor/Other)	10/10/0/0/0/0/0/0/0/0	0	0	20
Religion (Muslim/Christian/Jewish/Hindu/Buddhist/Sikh/Other)	10/10/0/0/0/0/0	0	0	20
Country of origin (India/Pakistan/Bangladesh/Sri Lanka/Other)	10/10/0/0	0	0	20
Time of arrival in the country (Less than 1 year/1-5 years/More than 5 years)	10/10/0	0	0	20
Reason for migration (Refugee/Student/Worker/Other)	10/10/0	0	0	20
Current residence (Urban/Rural)	10/10	0	0	20
Family size (Number of family members)	4.5	1.5	1	10
Annual income (USD)	1200	500	0	3000
Health insurance (Yes/No)	10/10	0	0	20
Employment status (Employed/Unemployed)	10/10	0	0	20
Language spoken at home (English/Other)	10/10	0	0	20
Language spoken at work (English/Other)	10/10	0	0	20
Language spoken with friends (English/Other)	10/10	0	0	20
Language spoken with family (English/Other)	10/10	0	0	20
Language spoken with neighbors (English/Other)	10/10	0	0	20
Language spoken with strangers (English/Other)	10/10	0	0	20
Language spoken in public places (English/Other)	10/10	0	0	20
Language spoken in media (English/Other)	10/10	0	0	20
Language spoken in government offices (English/Other)	10/10	0	0	20
Language spoken in educational institutions (English/Other)	10/10	0	0	20
Language spoken in religious institutions (English/Other)	10/10	0	0	20
Language spoken in social settings (English/Other)	10/10	0	0	20
Language spoken in professional settings (English/Other)	10/10	0	0	20
Language spoken in legal settings (English/Other)	10/10	0	0	20
Language spoken in medical settings (English/Other)	10/10	0	0	20
Language spoken in judicial settings (English/Other)	10/10	0	0	20
Language spoken in administrative settings (English/Other)	10/10	0	0	20
Language spoken in public administration settings (English/Other)	10/10	0	0	20
Language spoken in public service settings (English/Other)	10/10	0	0	20
Language spoken in public utility settings (English/Other)	10/10	0	0	20
Language spoken in public safety settings (English/Other)	10/10	0	0	20
Language spoken in public health settings (English/Other)	10/10	0	0	20
Language spoken in public education settings (English/Other)	10/10	0	0	20
Language spoken in public culture settings (English/Other)	10/10	0	0	20
Language spoken in public entertainment settings (English/Other)	10/10	0	0	20
Language spoken in public recreation settings (English/Other)	10/10	0	0	20
Language spoken in public leisure settings (English/Other)	10/10	0	0	20
Language spoken in public sports settings (English/Other)	10/10	0	0	20
Language spoken in public fitness settings (English/Other)	10/10	0	0	20
Language spoken in public wellness settings (English/Other)	10/10	0	0	20
Language spoken in public mental health settings (English/Other)	10/10	0	0	20
Language spoken in public social services settings (English/Other)	10/10	0	0	20
Language spoken in public community services settings (English/Other)	10/10	0	0	20
Language spoken in public social welfare settings (English/Other)	10/10	0	0	20
Language spoken in public social support settings (English/Other)	10/10	0	0	20
Language spoken in public social care settings (English/Other)	10/10	0	0	20
Language spoken in public social assistance settings (English/Other)	10/10	0	0	20
Language spoken in public social aid settings (English/Other)	10/10	0	0	20
Language spoken in public social relief settings (English/Other)	10/10	0	0	20
Language spoken in public social rescue settings (English/Other)	10/10	0	0	20
Language spoken in public social recovery settings (English/Other)	10/10	0	0	20
Language spoken in public social restoration settings (English/Other)	10/10	0	0	20
Language spoken in public social rehabilitation settings (English/Other)	10/10	0	0	20
Language spoken in public social reintegration settings (English/Other)	10/10	0	0	20
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Language spoken in public social reclassification settings (English/Other)	10/10	0	0	20
Language spoken in public social reassignment settings (English/Other)	10/10	0	0	20
Language spoken in public social redistribution settings (English/Other)	10/10	0	0	20



Fig. 7



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Fig. 8

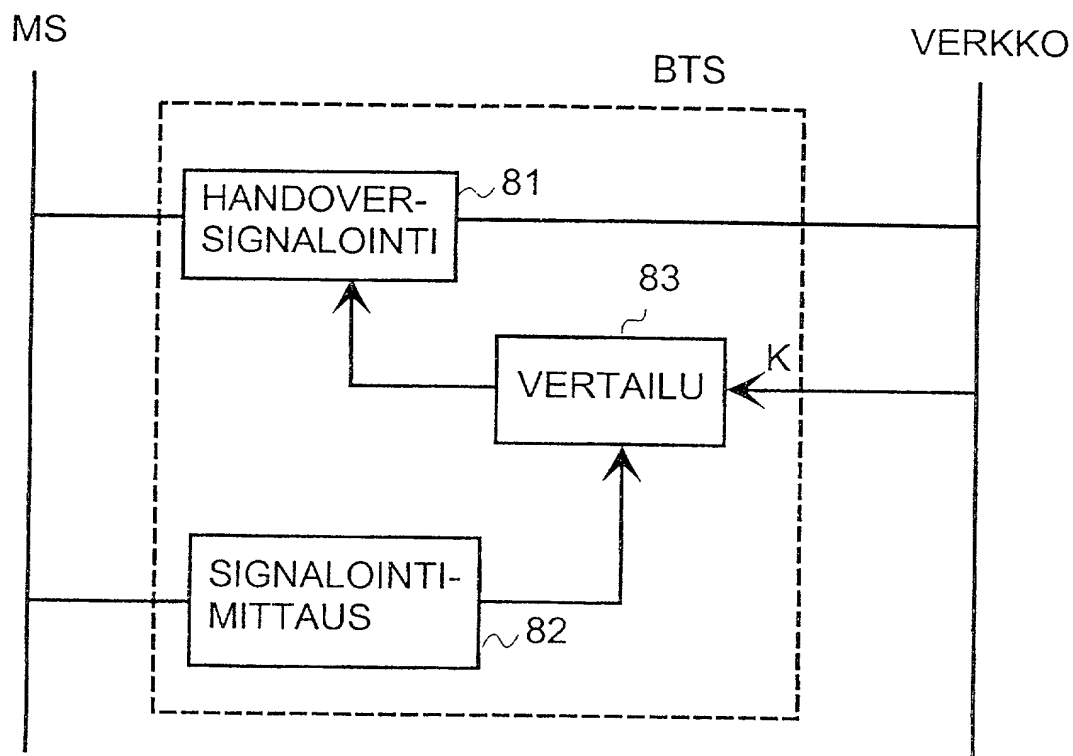


Table 1. Demographic characteristics of the study population	
Age (years)	Mean (SD)
Male	65.2 (10.5)
Female	68.5 (11.2)
Marital status	
Married	72.5%
Single	27.5%
Education level	
High school or above	68.5%
Below high school	31.5%
Occupation	
Retired	75.5%
Unemployed	24.5%
Income (USD/month)	
< 1000	15.5%
1000-2000	45.5%
> 2000	39.0%
Health insurance	
Yes	85.5%
No	14.5%
Comorbidities	
Hypertension	55.5%
Diabetes	35.5%
Cholesterol	45.5%
Smoking status	
Current smoker	15.5%
Former smoker	35.5%
Non-smoker	49.0%

**Altera Law Group, LLC**

**Declaration and Power of Attorney Patent Application  
(Design or Utility)**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**HANDOVER-METHOD IN CELLULAR RADIO SYSTEM WITH TWO FREQUENCY BANDS**

the specification of which

- ☐ is referred to by Altera reference number on a separate document  
☒ is attached hereto  
☐ was filed on \_\_\_\_\_ as application serial no. \_\_\_\_\_ and or PCT International Application number \_\_\_\_\_ and was amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information know to me to be material to patentability as defined in 37 C.F.R. §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or 35 U.S.C. §365(b) of any foreign application(s) for patent or inventor's certificate, or 35 U.S.C. §365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate of PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)		
Number 981486	Country Finland	Day/Month/Year Filed 26 June 1998
Number	Country	Day/Month/Year Filed
Number	Country	Day/Month/Year Filed

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I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below:

Prior Provisional Application(s)	
Serial Number	Day/Month/Year Filing Date
Serial Number	Day/Month/Year Filing Date
Serial Number	Day/Month/Year Filing Date

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s), or under 35 U.S.C. §365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. §1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

Prior U.S. or International Application(s)		
Serial Number PCT/FI99/00566	Day/Month/Year Filed 24 June 1999	Status (patented, pending, abandoned) Pending
Serial Number	Day/Month/Year Filed	Status (patented, pending, abandoned)
Serial Number	Day/Month/Year Filed	Status (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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## Power of Attorney

As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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Michael B. Lasky      Reg. No. 29,555  
Iain A. McIntyre      Reg. No. 40,337

I hereby authorize them or others whom they may appoint to act and rely on instructions from and communicate directly with the person/organization who/which first sends this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct Altera Law Group, LLC otherwise.

Please direct all correspondence in this case to Altera Law Group, LLC at the address indicated below:

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Signature of Inventor		Date